# Analysis of the Pedagogical Factors Influencing the Use and Effectiveness of a Game-Based Learning App from Teachers' Perspectives

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**Abstract**
This study sought to identify key determinants influencing teachers' satisfaction with the use of a game-based learning application in pre-university education. To achieve this objective, a comprehensive research methodology was employed, integrating components from three theoretical frameworks: the Information Systems Success Model (ISSM), the Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT). The analysis utilized a triangulated approach, leveraging structural equation modeling through SmartPLS 2.0.M3. Empirical data were gathered from a sample of 212 Spanish educators. Results showed that participants were well disposed towards the app and positive about the use of a game-based learning app when its design was clearly curriculum oriented and delivered on the essential curricular elements of content, competences, and education in values. As a predictor of efficacy, participants also appreciated the connection between the challenges students overcame to use the app and the assessment criteria established in the curriculum. Finally, the results for factor invariance were met for the variable of gender but not for age in teachers aged over 45.

*Keywords:* Game-based learning, app, satisfaction, efficacy, pre-university education

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The adoption of gamified digital tools, including educational applications, is influenced by a variety of factors that shape teachers' willingness to integrate them into their practice. Despite the limited body of research exploring educators' perspectives on digital game-based learning (DGBL), some studies highlight their views on the pedagogical and infrastructural opportunities and challenges associated with digital game-based learning applications (Kaimara et al., 2021. One notable advantage is the interactive nature of these tools, which fosters trial-and-error learning while capturing students' attention toward the instructional content (Bayrak & Liman-Kaban, 2024; Vrcelj et al., 2023). Additionally, such resources have been positively evaluated for enhancing conceptual understanding through supplementary visual aids, promoting creativity, and improving information processing (Demirbilek & Tamer, 2010). They also support the development of crucial interpersonal skills, such as teamwork, collaboration, and cooperative learning (Smith, 2018). Jodel and Palmquist (2021) further argue that these applications diversify instructional methods, making content delivery more inclusive across varied learning environments. Similarly, Marín et al. (2015) underscore that educators value the capacity of game-based learning tools to facilitate inductive learning, which helps students grasp foundational concepts of success and failure.

As for learning, several proposals emphasize that introducing DGBL into the classroom depends on the nature of the materials, not all of which are appropriate (Tibakanya, 2023). Another challenge is curriculum load that can limit the use of gamed-based activities, as they require significant time (Tandon, 2021). This relates directly to the overall lack of time to produce, implement, and cover the ideal amount of content. Teachers also express concerns about the lack of measurable results about the effectiveness of this methodology (Fisher et al., 2014). Additional barriers to DGBL include potential student distraction and lack of class control while students play (Attia et al., 2017). In these cases, the gaming aspect might prevail over lesson content, shifting students' focus away from learning. However, the opposite is also reported (Smith, 2018). The play factor of gamified teaching-learning processes can also reduce distraction and provide greater concentration on the task at hand, driven by the motivational nature of the game.

This study advances understanding of teacher satisfaction by integrating pedagogical and technological frameworks, offering actionable insights for curriculum-aligned design of game-based learning in pre-university education.

## Literature Review

***Digital Game-Based Learning (DGBL) and Gamification in the Curriculum***

Various perspectives exist about when and how to apply DGBL in the classroom. In this context, DGBL refers to the use of a games (video games, apps, simulation games, role-playing games, etc.) for training/educational purposes, aiming to enhance student's commitment to learning and intrinsic motivation. One of the main challenges for teachers is integrating these activities into the curriculum while aligning them with the established content and objectives (Hamari & Nousiainen, 2015). Some teachers favor occasional use of gamification. They argue it is most effective when applied at specific moments, such as during assessments, when teachers can intervene to correct errors in remediation stages or when assigning tasks for home practice (Mee Mee et al., 2020; Pektas & Kepceoglu, 2019; Smith, 2018). Pektas and Kepceoglu (2019) explain that, at the beginning of a formative process in the initial phases of instruction (where the foundations of the formative process are laid), gamification has been used as a motivational element to capture students' attention. However, Smith (2018) disputes this, arguing that gamified activities should always follow the presentation of content and strategies so students can retain concepts and connect with the content. In later stages of the initial instruction, some authors claim that gamification is most valuable for reinforcing knowledge and complementing summative assessments (Pektas & Kepceoglu, 2019; Smith, 2018).

The adoption of gamification, serious games, or game-based learning in teaching consistently depends on the perceived usefulness and ease of use that teachers attribute to these tools. However, their effective integration also requires rigorous curricular alignment. All DGBL must fit the requirements of a specific teaching unit, including a defined audience, clear objectives, activities scaled in difficulty and support materials (Fombona-Cadavieco et al., 2020). Game elements must also be fully integrated into the learning sequence and evaluation of instruments, so that the evidence generated directly measures competencies, skills, and knowledge (Vázquez-Ramos, 2021).

When these principles are met, the results are clear. The use of points, badges, and rankings increases all dimensions of the Technology Acceptance Model for Teachers (T-TAM) and reinforces the intention for future use among pre-service teachers (Yildiz et al., 2023). A favorable attitude toward serious games is mostly explained by intuitive interfaces that generate trust (Valencia & Duque, 2023) and by the perception of a simple and helpful classroom application (Sánchez-Mena, 2016). Even in expanded models, usability and ease of use remain the only significant predictors of teaching intention to employ digital game-based tools. This underscores the importance of clear and functional platforms rather than broader technological affinity (Luo, 2024). To consolidate these strategies in teacher education, it is essential to demonstrate their practical value, align them closely with curricular tasks, and provide mechanisms for social recognition within digital environments (Vanduhe et al., 2020).

In Tenório et al. (2020), teachers appreciate some of the features mentioned by experts, such as access to additional explanations of a game's functionality and formats for the presentation of results that facilitate assessment. They prefer results displayed in graphs rather than descriptive tables, with percentages that reflect students' achievement of objectives or summarize their interaction with the resources. Kiryakova et al. (2014) propose strategies such as defining learning objectives with multiple levels of difficulty, creating content adapted to students' level, and allowing students to choose from various learning paths. Kingsley and Grabner-Hagen (2015) argue that the success of digital game-based initiatives depends directly on a design that integrates gamified content into the curriculum. This can be achieved by incorporating game roadmaps that outline the necessary steps to achieve objectives, offering various difficulty levels, and providing visual and textual resources to facilitate concept comprehension. Key concepts should also be reinforced to foster a deeper understanding of the content. According to these authors, gamified elements must be creative and innovative while stimulating critical thinking, problem solving, communication and collaboration. Jodel and Palmquist (2021) further emphasize the importance of monitoring students' progress, which is also required in digital game-based learning initiatives. This quality, according to the authors and other experts, is one of the key functionalities of game design, as well as the ability to visualize results and include them in the assessments.

### ***Activator and Inhibitor Variables in the Use of Serious Games in the Curriculum***

Teachers have not yet fully integrated initiatives based on serious games into the school curriculum for several reasons. Serious games are designed with an explicit educational purpose. They are carefully structured and not intended primarily for entertainment, but rather to develop skills or promote learning (Abt, 1970). A major barrier is the lack of experience in applying new methodologies (Mumtaz, 2000) which complicates the integration of DGBL elements into formal education (Demirbilek & Tamer, 2010). Experience involves recognizing the benefits of the methodology, foreseeing how implementation will unfold and predicting outcomes, something that can be developed through specific training. Lack of training, therefore, is another variable hindering the use of DGBL. Training is particularly important in the early stages of adoption (Araujo & Carvalho, 2017; Demirbilek & Tamer, 2010; Fisher et al., 2014; Mee Mee et al., 2020). Green et al. (2014) also link lack of experience to difficulties in the selection of apps with content appropriate for knowledge acquisition. Clearly, teachers' limited experience and ability to implement DGBL initiatives must be addressed through specialized training. Teachers themselves have proposed training that includes theoretical elements on gamification and learning through games, practical examples of application, course planning and implementation, and development of assessment processes (Fisher et al., 2014; Kamisli, 2019; Shiota & Abe, 2015). In some cases, teachers also requested not only external training resources but also personalized support attention to apply this methodology effectively. The effectiveness of such training and its connection  to the positive effect of the variable of experience is illustrated in Jong's (2019) longitudinal study. Over a three-year period, it was observed that teachers' initial insecurities related simply to managing the introduction of the gamed elements into their classes. As training progressed, these concerns diminished, while new ones emerged about how to improve and expand the use of game-based learning in the school.

Experience, therefore, is considered a variable that directly influences teachers' attitudes towards the use of active methodologies such as gamification or DGBL. Andreu Andrés and Labrador Piquer (2011) report a negative correlation between lack of experience and the proactive use of DGBL. This finding is supported by other studies (Fisher et al., 2014; Hossein-Mohand et al., 2021), which highlight significant relations between experience and positive attitudes towards the application of this methodology. Marín et al. (2020) observe that new generations of teachers, already skilled in the use of technology, accept games with fewer reservations than those who have not received training in technology.

Teachers' beliefs about the pedagogical benefits of digital games are another variable. Among the authors consulted, there is unanimity of criteria: Personal beliefs are predictors of a proactive behavior in the use of gamification (Asiri, 2019; Ertmer et al., 2012; Mee Mee et al., 2020; Mumtaz, 2000; Smith, 2018). Using the Technology Acceptance Model (TAM), Asiri (2019) confirmed a relationship between perceived usefulness, social influence, affective and cognitive attitudes, and the intention to use. The study of teachers' sociodemographic factors and their influence on attitude includes variables such as age and sex. Marín et al. (2015) found that men are more active in the use of digital games. However, Fisher et al. (2014), Gómez-Carrasco et al. (2020) and Smith (2018) concluded that gender does not significantly influence attitude. No study found age to account for meaningful differences in teachers' attitude.

Alternatives to training have been proposed to guide and support teachers interested in applying a methodology that includes DGBL elements. These range from rubrics that help evaluate which applications are suitable for the pedagogical needs of the context (Walker, 2011), to analytical models or reference frameworks that enable teachers to design and adapt didactic gamified proposals (Lee & Hammer, 2011). Green et al. (2014) developed an app that evaluates the characteristics of digital apps to ascertain their pedagogical suitability for curricular integration. The pedagogical bases that the model includes emphasized authenticity in tools and procedures, opportunities for personalization (self-paced, self-regulation, customization) and collaboration, which is identified as a key component of learning. Papadakis et al. (2017) measured the practical effectiveness of applications in relation to educational content and their ability to help teachers make decisions on their use, given the lack of pedagogical evidence in many commercial apps. Walker's (2011) rubric considers some previously mentioned characteristics such as feedback's provision or content authenticity. Its main contribution, however, lies in determining whether and to what extent an app correlates with curricular skills and concepts. In this way, a positive evaluation depends largely on the app's alignment with the curriculum. On the other hand, Lee and Hammer (2011) propose a framework designed to guide teachers in boosting learning through cognitive, emotional, and social categories. Another framework for guiding gamified design in education is the "Edu-Game" (Vázquez-Ramos, 2021). It facilitates class planning by matching each didactic level (objectives, assessment criteria, methodology, content, and assessment) with a gamified equivalent. Ultimately, the analytical approach proposed by Tenório et al. (2020) allows for the adjustment of the design throughout the learning experience by tracking data on student interactions with system's resources.

***Conceptual Model, Measurement Instrument, and Analytical Approach***

The measurement instrument and analytical approach used in this study are explicitly grounded in a tripartite theoretical framework that integrates the Information Systems Success Model (ISSM; DeLone & McLean, 2003), the Technology Acceptance Model (TAM; Davis, 1989), and the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003). These models, while conceptually distinct, provide complementary perspectives on user interaction with educational technologies and collectively inform the structure of the proposed research model.

Specifically, ISSM contributes to the conceptualization of satisfaction as an evaluative outcome based on the perceived quality and usefulness of an information system. This model is particularly relevant for assessing post-adoption attitudes, making it suitable for evaluating educators' experiences with digital game-based learning applications. In this instrument, the satisfaction construct (S1–S3) is directly informed by ISSM and operationalized through items reflecting overall contentment with the tool's effectiveness and its integration into mobile learning environments.

TAM serves as the foundation for conceptualizing the constructs of perceived usefulness and perceived ease of use, both of which predict users' attitudes and intentions. The items developed under these constructs (UT1–UT4, US1–US3) reflect Davis's (1989) original dimensions and are central to understanding educators' motivational dispositions toward technology adoption.

Finally, UTAUT informs the broader socio-organizational factors influencing acceptance, particularly through the extension of TAM with constructs like attitude and performance expectancy. The construct attitude (A1–A4) in this study draws on this framework to assess teachers' general predisposition toward integrating game-based tools. The selection of Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 2.0 is also theoretically congruent, as this analytical technique is optimal for predictive modeling in exploratory studies that involve complex models and latent constructs derived from these theoretical frameworks.

Considering these three theoretical frameworks, we created an ad hoc instrument. While many items in the instrument were adapted from validated studies in the educational technology literature, the mapping of these items to constructs from ISSM, TAM, and UTAUT was systematically undertaken to ensure theoretical alignment. Constructs such as perceived usefulness, ease of use, attitude, and satisfaction have a well-established lineage within TAM and ISSM, and the items developed under these constructs preserve the semantic structure and intent of the original models (e.g., UT1–UT4, US1–US3, A1–A4, S1–S3).

However, certain constructs introduced in the model—such as curriculum connection and assessment and learning analytics—extend beyond the original scope of technology acceptance theories. These constructs were added to capture pedagogically relevant dimensions that influence teachers' willingness to adopt game-based learning applications. Although not explicitly derived from TAM or UTAUT, they are consistent with more recent extensions of these models that incorporate contextual and educational variables (Teo, 2009; Wong, 2016). For instance, curriculum connection can be theorized as a precursor to perceived usefulness in educational contexts, since alignment with curricular goals directly impacts perceived instructional value. To strengthen construct validity, each item was mapped to the theoretical definitions of its latent variable, and semantic coherence was confirmed through iterative item refinement. Furthermore, content validity was confirmed using the Delphi methodology (Okoli & Pawlowski, 2004).

Through this combined theoretical and empirical strategy, the instrument maintains theoretical robustness while remaining responsive to the unique pedagogical contexts of pre-university education. The construction of the survey instrument was explicitly informed by the integration of the Information Systems Success Model (ISSM), the Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT). Each latent construct and its associated items were designed to operationalize key theoretical dimensions derived from these models, ensuring both conceptual coherence and empirical measurability.

The “Perceived Usefulness” dimension (UT1–UT4) is directly rooted in TAM (Davis, 1989 and reflects users’ beliefs that using a digital game-based learning application enhances instructional effectiveness. Items such as UT1 ("enrich my educational activities") and UT4 ("get better results") also align with the construct of performance expectancy in UTAUT and information quality in ISSM, thus supporting multidimensional interpretation. The “Perceived Ease of Use” construct (US1–US3) also derives from TAM, capturing the effort expectancy component identified in UTAUT. Items such as US1 ("easy to use") and US3 ("easy to learn") address the usability and learnability aspects emphasized in both TAM and ISSM’s system quality dimension. The “Attitude” dimension (A1–A4), while part of TAM’s extended models, also connects to behavioral intention predictors in UTAUT. Positive perceptions toward gamified applications (e.g., A2: “teaching more enriched”) represent affective and motivational antecedents to adoption. The “Satisfaction” construct (S1–S3) is foundational in ISSM, where satisfaction is understood as a key post-use evaluative factor. Items such as S1 and S3 reflect the users' overall contentment with the technology's ability to meet pedagogical goals and personal teaching needs. “Learning Efficacy” (EF1–EF3) can be interpreted as a construct that mediates between perceived usefulness and satisfaction, extending TAM and ISSM to capture instructional outcomes. This aligns with performance-related variables in UTAUT, further reinforcing its inclusion. Although the constructs "Curriculum Connection" (CI1–CI5) and "Assessment and Learning Analytics" (AS1–AS2) are not explicitly found in TAM or UTAUT, they are included as contextual extensions. For instance, CI3 ("align with curricular content") and AS1 ("correspond to evaluation standards") function as antecedents to perceived usefulness and satisfaction. These items reflect domain-specific adaptations of facilitating conditions and task-technology fit, aligning with contemporary applications of UTAUT in educational contexts (Wong, 2016; Teo, 2009).

Based on the principles of the theoretical framework discussed, we propose the following hypotheses and structural model (Figure 1).

Ease-of-use
H1: Perceived usefulness has a positive effect on attitude towards use of an app.
H2: Perceived ease-of-use has a positive effect on perceived usefulness.
H3: Perceived ease-of-use has a positive effect on attitude towards use of the technology.

Attitude
H4: A positive attitude towards use of the technology has a positive effect on learning efficacy.

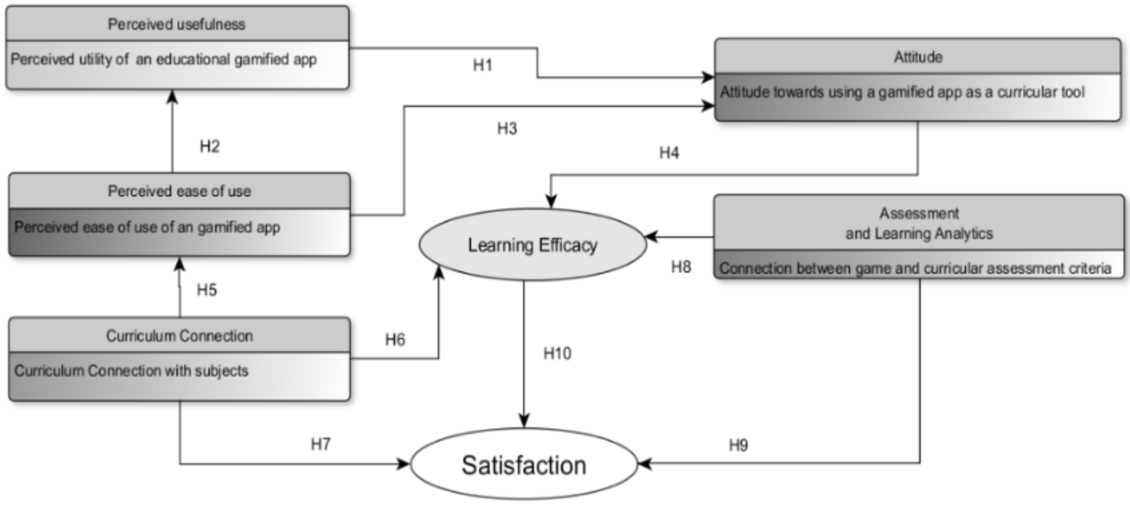
Curriculum connection
H5: Curricular connection influences perceived ease-of-use.
H6: Curricular connection has a positive effect on learning efficacy.
H7: Curricular connection has a positive effect on satisfaction.

Assessment and Learning analytics
H8: The higher the level of alignment between assessment criteria and gamified challenges, the greater the influence on learning efficacy.
H9: A higher level of feedback through learning analytics has a positive effect on teachers' satisfaction.

Learning efficacy
H10: The higher the level of learning efficacy, the stronger the positive influence on teachers' satisfaction.

**Figure 1**

*Structural Model*




# Methodology

As highlighted by Li et al. (2013), understanding the interplay between educators' professional experiences, perceptions, system usability, quality, alignment with curriculum, and assessment strategies is essential for evaluating the effectiveness of gamified educational applications. Analyzing these dimensions can help identify areas for improvement, thereby supporting high-quality teaching practices and fostering mobile and ubiquitous learning environments. For this study, we developed a methodological framework incorporating elements from the ISSM, TAM, and UTAUT. To analyze the pedagogical variables affecting the adoption of gamified educational tools, we employed Partial Least Squares (PLS) modeling using SmartPLS 2.0 software (Ringle et al., 2005). The sample size adhered to the rule of exceeding ten times the highest number of predictors for any dependent variable, as recommended by Chin (1998), ensuring robustness with more than 50 participants. Additionally, we conducted an analysis of factor invariance, focusing on demographic variables such as gender and age (under 45 years).

***Participants, Instrument, and Variables***

The research sample comprised 212 Spanish educators working in public primary and secondary schools across 16 autonomous regions of Spain, with a gender distribution of 32.1% male and 67.9% female participants. Among these respondents, 38.7% were employed in primary education, 32.8% in secondary education, and 28.5% in post-secondary levels. The average age of the participants was approximately 34 years (M = 33.14, SD = 2.41).

The sample was intentionally diverse, including teachers from various grade levels instructing students aged 6 to 18. All participating teachers possessed prior experience in developing activities aimed at the curricular integration of gamification within the educational stages where they were actively teaching. The survey was distributed via the official email addresses of the participating schools.

The questionnaire is presented in Table 1 with 24 items categorized under seven latent constructs on a Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").

**Table 1**

*Latent Variables and Items*

| Category | Dimension | Items | Authors |
|---|---|---|---|
| Utility | Perceived utility of an educational gamified app | UT1. An educational gamified app enables me to enrich my educational activities in/outside the classroom.<br>UT2. An educational gamified app helps students to become self-sufficient learners.<br>UT3. An educational gamified app helps me to increase the motivation in the subjects I teach.<br>UT4. An educational gamified app helps me to get better results in the subjects I teach. | Lee & Cherner (2015); Papadakis & Kalogiannakis (2017); Vázquez-Cano et al. (2021). |
| Use | Perceived ease of use of a gamified app | US1. An educational gamified app is easy to use.<br>US2. The ease of use of an app enables students to be connected ubiquitously.<br>US3. It is easy to learn how to use an educational gamified app. | Huber et al. (2016) ; Lee (2009). Kalogiannakis, & Papadakis (2019). Liu et al. (2021); Vázquez-Cano et al. (2022, 2023). |
| Currículum Connection | Currículum Connection | CI1. A gamified educational application should prioritize the cultivation of domain-specific skills and competencies.<br>CI2. A gamified educational application should support the enhancement of cross-disciplinary or transferable skills.<br>CI3. A gamified educational application should align with and reinforce the curricular content of one or more academic subjects.<br>CI4. A gamified educational application should promote the teaching and integration of core values within the learning experience.<br>CI5. A gamified educational application should incorporate structured learning scenarios to foster meaningful engagement. | Vázquez-Cano et al. (2022; 2023). |
| Attitude | Attitude towards using a gamified | A1. Using an educational gamified app is a good idea.<br>A2. An educational gamified app makes teaching more enriched. | Wartella (2015). Van Deursen et al. (2016). Hu & Garimella (2014); |

| | | | |
|---|---|---|---|
| | app as a curricular tool | A3. Using an educational gamified app is fun.<br>A4. I would like to integrate in my teaching the use of an educational gamified app. | Khlaif (2018); Teo & Noyes (2011); Vázquez-Cano et al. (2022). |
| Assessment and Learning Analytics | Assessment and Learning Analytics | AS1. The achievement of challenges within the application should correspond to meeting the curriculum's evaluation standards.<br>AS2. The gamified educational application should deliver personalized feedback to enhance student performance and facilitate reflective learning. | Kovanovic et al. (2021) ; Choi et al. (2018). |
| Efficacy | Learning Efficacy | EF1. I am of the opinion that utilizing an educational gamified app enhances my teaching effectiveness.<br>EF2. I believe that an educational gamified app aids students in acquiring a deeper understanding of the subject matter.<br>EF3. I am convinced that an educational gamified app boosts students' motivation to engage in learning. | Chiong (2012); Vázquez-Cano et al. (2022). |
| Satisfaction | Satisfaction with a gamified app | S1. I am content with utilizing a gamified educational application as a tool to enhance my instructional approach.<br>S2. I am pleased with the effectiveness of mobile and ubiquitous learning in my teaching practices.<br>S3. A gamified educational application effectively meets my learning requirements. | Alsawaier (2018); Aydınlıyurt et al. (2021) |

# Results

To assess the dimensionality and underlying factor structure of the measurement instrument, an exploratory factor analysis (EFA) was conducted prior to the confirmatory analyses. The Kaiser-Meyer-Olkin (KMO) was 0.77. Factors were extracted using principal axis factoring with varimax rotation, and the number of retained factors was determined based on eigenvalues greater than 1 (Table 2).

**Table 2**

*Exploratory Factor Analysis (EFA)*

| Item | F. 1 Use | F. 2 Utility | F. 3 Curr. Conn | F. 4 Attitude | F. 5 Efficacy | F. 6 Assess | F. 7 Satisf. |
|---|---|---|---|---|---|---|---|
| US1 | .879 | | | | | | |
| US2 | .861 | | | | | | |
| US3 | .843 | | | | | | |
| UT1 | | .711 | | | | | |
| UT2 | | .687 | | | | | |
| UT3 | | .834 | | | | | |
| UT4 | | .811 | | | | | |
| CC1 | | | .843 | | | | |
| CC2 | | | .834 | | | | |
| CC3 | | | .811 | | | | |
| CC4 | | | .789 | | | | |
| CC5 | | | .823 | | | | |
| A1 | | | | .785 | | | |
| A2 | | | | .876 | | | |
| A3 | | | | .813 | | | |
| A4 | | | | .867 | | | |
| EF1 | | | | | .900 | | |
| EF2 | | | | | .895 | | |
| EF3 | | | | | .837 | | |
| AL1 | | | | | | .821 | |
| AL2 | | | | | | .832 | |
| S1 | | | | | | | .901 |
| S2 | | | | | | | .923 |
| S3 | | | | | | | .971 |

The EFA results revealed a clear factor structure consistent with the theoretical model, explaining a substantial proportion of the total variance. Factor loadings exceeded the recommended threshold of 0.40, indicating that items loaded strongly on their respective latent constructs. These exploratory findings provided empirical support for proceeding to the confirmatory phase using structural equation modeling (SEM), ensuring that the latent constructs were both conceptually and empirically distinguishable

First, the validity and reliability of the scales were tested. The Cronbach's alpha coefficient was above 0.8, and the Kaiser-Meyer-Olkin (KMO) was 0.77. The measurement model's validity and reliability were thoroughly examined, placing particular emphasis on the consistency of individual items. The convergent and discriminant validity were evaluated (Tables 3 and 4).

**Table 3**

*Convergent and Discriminant Validity*

| Factors | | λ | Cronbach's α | CR (Composite Reliability) | AVE |
|---|---|---|---|---|---|
| *Perceived utility of an educational gamified app* | | | 0.823 | 0.831 | 0.716 |
| UT1 | Utility | 0.711 | | | |
| UT2 | Utility | 0.687 | | | |
| UT3 | Utility | 0.834 | | | |
| UT4 | Utility | 0.811 | | | |
| *Perceived ease of use of a gamified app* | | | 0.921 | 0.919 | 0.801 |
| US1 | Use | 0.893 | | | |
| US2 | Use | 0.901 | | | |
| US3 | Use | 0.878 | | | |
| *Curriculum Connection* | | | 0.921 | 0.900 | 0.750 |
| CC1 | Curri.C. | 0.843 | | | |
| CC2 | Curri.C. | 0.834 | | | |
| CC3 | Curri.C. | 0.811 | | | |
| CC4 | Curri.C. | 0.789 | | | |
| CC5 | Curri.C. | 0.823 | | | |
| *Attitude towards the use of a gamified app* | | | 0.925 | 0.911 | 0.711 |
| A1 | Attitude | 0.785 | | | |
| A2 | Attitude | 0.876 | | | |
| A3 | Attitude | 0.813 | | | |
| A4 | Attitude | 0.867 | | | |
| *Learning Efficacy* | | | 0.931 | 0.919 | 0.798 |
| EF1 | Efficacy | 0.900 | | | |
| EF2 | Efficacy | 0.895 | | | |
| EF3 | Efficacy | 0.837 | | | |
| *Assessment and Learning Analytics* | | | 0.943 | 0.841 | 0.702 |
| AL1 | Assessment and L. Analytics | 0.821 | | | |
| AL2 | Assessment | 0.832 | | | |
| *Satisfaction with of a gamified app* | | | 0.941 | 0.935 | 0.830 |
| S1 | Satisfaction | 0.901 | | | |
| S2 | Satisfaction | 0.923 | | | |
| S3 | Satisfaction | 0.971 | | | |

Table 3 confirms the reliability of the individual items. Cronbach's alpha and Composite Reliability (CR) coefficients all surpass the 0.7 threshold. Furthermore, the Average Variance Extracted (AVE) exceeds 0.5. The discriminant validity is presented in Table 4 through a correlation matrix between the constructs, confirming that the correlations were lower than the square root of the AVE.

**Table 4**

*Discriminant Validity*

| | Use | Utility | Attitude | Curr. Co. | Efficacy | Ass-La | Satisfaction |
|---|---|---|---|---|---|---|---|
| Use | **0.897** | | | | | | |
| Utility | 0.521 | **0.801** | | | | | |
| Attitude | 0.553 | 0.611 | **0.834** | | | | |
| Curr. Co. | 0.633 | 0.579 | 0.722 | **0.878** | | | |
| Efficacy | 0.567 | 0.534 | 0.713 | 0.560 | **0.880** | | |
| As. L.Analyt. | 0.723 | 0.590 | 0.567 | 0.711 | 0.541 | **0.786** | |
| Satisfaction | 0.751 | 0.721 | 0.661 | 0.598 | 0.801 | 0.601 | **0.902** |

The squared multiple correlation coefficient was above 0.5, signifying a robust explanatory capacity. Moreover, the factor loadings between the constructs were determined to be statistically significant. A summary of the structural model and the hypothesis testing outcomes is presented in Table 5.

**Table 5**

*Hypothesis Testing Results*

| Hypothesis | Path | Path Coefficient | Results |
|---|---|---|---|
| H1 | Perceived usefulness → Attitude | 0.195** | Supported |
| H2 | Perceived ease-of-use → Perceived usefulness | 0.458*** | Supported |
| H3 | Perceived ease-of-use → Attitude | 0.351** | Supported |
| H4 | Attitude → Learning Efficacy | 0.601*** | Supported |
| H5 | Curricular connection → Ease-of-use | 0.098 | Not Supported |
| H6 | Curricular Connection → Learning Efficacy | 0.599*** | Supported |
| H7 | Curricular Connection → Satisfaction | 0.578*** | Supported |
| H8 | Assessment → Learning Efficacy | 0.551*** | Supported |
| H9 | Learning Analytics → Satisfaction | 0.411*** | Supported |
| H10 | Efficacy → Satisfaction | 0.466*** | Supported |

*p<0.1, **p<0.05, ***p<0.01

Table 5 presents the findings from the PLS analysis, which confirm the support for all hypotheses with the exception of Hypothesis H5, which pertains to the direct impact of Curricular Connection on Ease-of-use. Table 6 presents the direct and indirect effects.

**Table 6**

*Total Effects (Direct and Indirect Effects)*

| | Curr. Co. | Ass-La | Use | Utility | Attitude | Efficacy | Satisfaction |
|---|---|---|---|---|---|---|---|
| Use | 0.000 | 0.000 | 0.000 | 0.458 | 0.351 | 0.000 | 0.000 |
| Utility | 0.000 | 0.000 | 0.458 | 0.000 | 0.000 | 0.000 | 0.000 |
| Attitude | 0.000 | 0.000 | 0.351 | 0.195 | 0.000 | 0.000 | 0.000 |
| Efficacy | 0.599 | 0.551 | 0.000 | 0.000 | 0.601 | 0.000 | 0.000 |
| Satisfaction | 0.578 | 0.411 | 0.155 | 0.392 | 0.159 | 0.466 | 0.000 |

The results indicate that the variable “curricular connection” has the strongest impact on “satisfaction.” An increase in the "curricular connection" score within a unit corresponds to a 0.578 rise in satisfaction, making it as the most influential predictor of satisfaction. The next key predictors of satisfaction are “learning efficacy" (0.466) and "assessment and learning analytics" (0.411). Analysis of the total effect values shows that perceived ease of use emerges as a critical factor in predicting individuals’ attitudes toward technology adoption (0.351). Moreover, “assessment and learning analytics” is identified as the primary determinant of “efficacy” (0.551). Table 7 provides an overview of the goodness-of-fit indices for the structural model.

**Table 7**

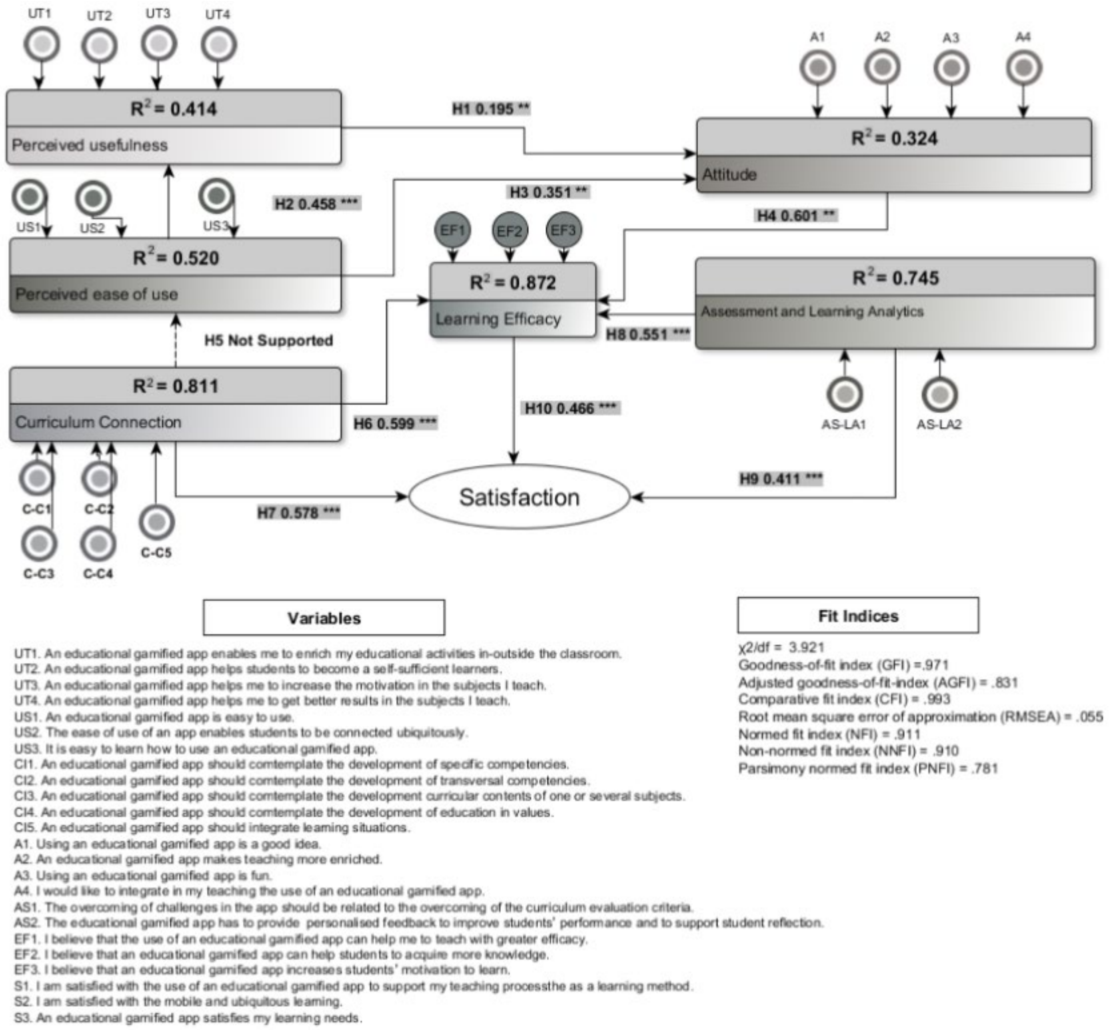
*Fit Indices for the Structural Equations Model*

| Fit index | Recommended value | Actual |
|---|---|---|
| $\chi^2$/df | <3 preferable <5 | 3.921 |
| Goodness-of-fit index (GFI) | >.81 | .971 |
| Adjusted goodness-of-fit-index (AGFI) | >.87 | .831 |
| Comparative fit index (CFI) | >.91 | .993 |
| Root mean square error of approximation | <.09 | .055 |
| (RMSEA) | >.91 | .911 |
| Normed fit index (NFI) | >.91 | .910 |
| Non-normed fit index (NNFI) | >.61 | .781 |
| Parsimony normed fit index (PNFI) | | |
| Average standardized factor loading | > 0.70 | 0.833 |
| Average Composite Reliability (CR) | > 0.70 | 0.895 |
| Average Variance Extracted (AVE) | > 0.50 | 0.737 |
| Discriminant validity (Fornell-Larcker) | Square root of AVE > correlations | Confirmed |
| Squared multiple correlations ($R^2$) | > 0.50 | All > 0.50 |
| Total variance explained (Satisfaction) | - | 78.3% |

Building on this analysis, Figure 2 illustrates the path coefficients for each relationship, accompanied by their respective significance levels (denoted by asterisks: *p<0.1, **p<0.05, ***p<0.01), as well as the $R^2$ values for each endogenous variable and the statistical significance of the relationships within the model.

**Figure 2**

*SEM Analysis of the Research Model*




The model accounted for a significant proportion of the variance in all endogenous variables: "as-la" (74.5%), "curr. co." (81.1%), and "efficacy" (87.2%). According to Falk and Miller (1992), the coefficient of determination ($R^2$) should exceed 0.10. The only exception in this study was the relationship between "curriculum connection" and "perceived ease of use," which did not meet this threshold. All other endogenous variables fulfilled this criterion, demonstrating a strong explanatory capacity for the observed variations and suggesting the model's stability and reliability. Additionally, we conducted a thorough analysis of nested participant groups (e.g., male vs. female, under and over 45 years of age) by applying a series of progressive and sequential restrictions to assess configural, metric, scalar, and strict invariance. We began by testing configural invariance to ensure equivalence in factor structures across groups. Next, metric invariance was examined, and finally, we applied stricter constraints during the scalar invariance test to confirm that intercepts were invariant across groups. For evaluating the different degrees of invariance, we used indices such as the $\chi 2$ / df ratio, CFI, TLI and RMSEA. Variations in CFI were considered acceptable if below, 0.01 (Cheung & Rensvold, 2002) and variations in RMSEA were acceptable if less than 0.015 (Chen, 2007). (Table 8).

**Table 8**

*Invariance Model Fit Parameters of the Model Across Groups by Sex and Age*

| Groups and invariance | $\chi2$ | df | TLI | $\chi2_{df}$ | CFI | RMSEA | AIC | ΔCFI |
|---|---|---|---|---|---|---|---|---|
| *Sex* | | | | | | | | |
| Configural invariance | 129.110 | 88 | .926 | 1.986 | .939 | .048 | 305.315 | |
| Metric invariance | 154.001 | 73 | .936 | 2.001 | .941 | .050 | 310.001 | .003 |
| Scalar invariance | 160.321 | 87 | .973 | 1.986 | .988 | .047 | 296.065 | .001 |
| Strict invariance | 217.101 | 108 | .985 | 2.131 | .986 | .046 | 311.199 | .005 |
| *Age* | | | | | | | | |
| Configural invariance | 167.302 | 89 | .969 | 1.699 | .970 | .049 | 431.734 | |
| Metric invariance | 202.114 | 103 | .941 | 1.801 | .944 | .043 | 440.444 | .002 |
| Scalar invariance | 262.610 | 118 | .955 | 1.998 | .960 | .047 | 455.008 | .005 |
| Strict invariance | 467.465 | 187 | .976 | 2.810 | .947 | .067 | 599.976 | .041 |

Note: $\chi^2$ (Chi-square approximation of goodness-of-fit), *df* (Degrees of Freedom), *TLI* (Robust Tucker Lewis Index), *CFI* (Comparative Fit Index), *RMSEA* (Root Mean Square Error Approximation), *AIC* (Akaike's Information Criterion).

The results in the case of the variable "gender" fall within the margins required to accept the goodness of the model ($\chi2$ / df, = 2.131; CFI = .986; TLI = .985 and RMSEA = .046). For the variable "age", the goodness values of the strict invariance model also fall within acceptable limits ($\chi2$ / df, = 2.810; CFI = .987; TLI = .976 and RMSEA = .067). However, in this case, the CFI variation exceeds 0.01, RMSEA also exceeds 0.015 and the AIC increases substantially. Therefore, "strict invariance" is rejected, and the less restrictive "scalar invariance" model is accepted." Analyzing the structural model by the two "age" shows equivalence across the three models, except for the relationship between "efficacy" and "satisfaction." This relationship is not significant for teachers over 45 years of age. To analyze the possible differences, given that the assumption of normality was not verified, a non-parametric Kruskal-Wallis test was performed on the latent variable items "efficacy" and "satisfaction." The findings suggest that notable differences exist between the variables EFI and EF2 (Table 9).

**Table 9**

*Kruskal-Wallis Test*

| | EF1 | EF2 | EF3 | S1 | S2 | S3 |
|---|---|---|---|---|---|---|
| Chi-Square | 1.427 | 9.778 | 1.201 | 4.145 | 4.890 | 4.213 |
| df | 5 | 5 | 5 | 4 | 5 | 4 |
| Asymp. Sig. | .003 | .004 | .189 | .196 | .189 | .178 |

When comparing the mean scores for the items comprising the "Efficacy" dimension across the two age groups, participants over 45 years of age obtained lower scores than those under 45 on EF1, "I believe that using a gamified educational application enhances my teaching effectiveness" ($M > 45 = 3.01$ vs. $M < 45 = 4.01$), and EF2, "I believe that a gamified educational application helps students develop a deeper understanding of the subject matter" ($M > 45 = 2.89$ vs. $M < 45 = 3.88$). For EF3, "I am convinced that a gamified educational application increases students' motivation to engage in learning," the reported results did not indicate a statistically significant difference between the two groups ($p = .189$), although participants under 45 had a slightly higher mean score at the descriptive level ($M > 45 = 3.90$ vs. $M < 45 = 4.27$).

Taken together, the results provide robust evidence for the validity of the proposed PLS-SEM model. The measurement model demonstrated high reliability, with Cronbach's α and Composite Reliability values exceeding 0.80, and AVE values above 0.50. Factor loadings ranged from 0.687 to 0.971, confirming convergent validity, while discriminant validity was supported by the Fornell–Larcker criterion.

The structural model accounted for substantial variance across constructs: 74.5% in Assessment and Learning Analytics, 81.1% in Curriculum Connection, 87.2% in Efficacy, and 78.3% in Satisfaction. Nine of ten hypotheses were supported. Key paths included Perceived Ease of Use → Perceived Usefulness ($\beta = 0.458$, $p < 0.01$), Attitude → Efficacy ($\beta = 0.601$, $p < 0.01$), and Efficacy → Satisfaction ($\beta = 0.466$, $p < 0.01$). Curricular Connection was the strongest total predictor of Satisfaction ($\beta = 0.578$), followed by Efficacy ($\beta = 0.466$) and Assessment/Analytics ($\beta = 0.411$). Only the link between Curricular Connection and Ease of Use was not significant ($\beta = 0.098$).

Multi-group invariance testing confirmed full equivalence across gender but only partial invariance across age. Teachers over 45 reported lower efficacy means (EF1 = 3.01 vs. 4.01; EF2 = 2.89 vs. 3.88), and the efficacy–satisfaction path was non-significant.

No significant differences were detected across educational stages. Invariance and non-parametric tests indicated that the structural relationships and item responses were consistent regardless of the school level in which teachers were employed. This finding suggests that the determinants of satisfaction with gamified applications operate similarly across pre-university stages, supporting the generalizability of the proposed model. Overall, the analysis highlights curricular alignment, efficacy, and robust feedback mechanisms as decisive drivers of teacher satisfaction with gamified educational applications.

# Discussion

The present study investigated the determinants of teacher satisfaction with game-based educational applications, using a comprehensive analytical framework that integrates the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Information Systems Success Model (ISSM). While the majority of hypothesized relationships were statistically supported, one notable exception (Hypothesis H5) failed to demonstrate a significant direct relationship between curricular connection and perceived ease of use. This outcome invites a deeper conceptual exploration of the interaction between pedagogical alignment and usability. According to UTAUT (Venkatesh et al., 2003), facilitating conditions such as curriculum alignment are theorized to indirectly influence perceived ease of use by reducing barriers to technology integration. However, the present findings challenge this assumption, suggesting that strong curricular alignment may increase design complexity and cognitive load, particularly for teachers with limited digital proficiency. This observation aligns with prior research indicating that sophisticated, pedagogically robust features can paradoxically hinder usability (Zaharias & Poylymenakou, 2009; Alshammari et al., 2016). The study, therefore, underscores the need for a balanced, user-centered design approach that maintains pedagogical fidelity while ensuring interface simplicity. Moreover, the non-significant H5 relationship may be moderated by factors such as teachers' digital competence, experience with gamified tools, and instructional context. This aligns with the moderating effects proposed in the TAM extensions (King & He, 2006) and suggests that curricular connection alone is insufficient to enhance usability perceptions among less technologically confident educators. Incorporating these moderating variables into future models would allow for a more nuanced understanding of the interplay between pedagogical and technical dimensions in educational technology adoption.

Interestingly, the study's total effects analysis reveals that curricular connection exerts a strong indirect influence on satisfaction through learning efficacy. This finding supports the argument that curricular alignment functions primarily as a cognitive-affective enhancer rather than a direct usability driver. Teachers' perceptions of an application's alignment with curricular goals enhance their sense of instructional efficacy, which in turn amplifies satisfaction—a mechanism consistent with Bandura's (1997) social cognitive theory and its emphasis on self-efficacy as a determinant of motivation and satisfaction. In line with prior research (Al-Maroof & Al-Emran, 2018; Kim & Kim, 2017), the study confirms that perceived usefulness and perceived ease of use are critical predictors of attitude toward technology adoption, which subsequently influences learning efficacy and satisfaction. In this sense, Kim & Kim (2017), Matarirano et al. (2021) and Al-Maroof et al. (2021) detected perceived usefulness as an indicator of use in their respective studies. Although gamified apps can improve learning due to their portability, immediacy, adaptability, and interactivity, design determines their efficacy. The use of gamification by teachers will, therefore, be influenced by the perception they have of its efficiency; numerous studies demonstrate the efficacy of gamification in boosting student creativity, critical thinking, motivation, collaboration, and communication (Kingsley & Grabner-Hagen, 2015) in creating a better class atmosphere and improving student performance (González; Blanco, 2008; Fitz-Walter et all, 2011; Barata et Al., 2013; Li Et Al., 2013; González & Mora, 2014; Welbers et al. 2019). This sequential mediation pattern highlights the multifaceted pathways through which technical and pedagogical attributes interact to shape teachers' acceptance and satisfaction.

Furthermore, the results show that assessment and learning analytics significantly predict learning efficacy, emphasizing the importance of integrating feedback mechanisms and data-driven insights into gamified applications (Ifenthaler, 2021; Choi et al., 2018). Studies by Walker (2011) and Clark et al. (2016) emphasize the importance of effective feedback that includes bifurcation based on students' answers and attention to partially correct answers, in other words, feedback that can redirect students towards the fully correct answer. It is also important that teachers can view how students use the app in order to t make decisions based on their efforts and progress within the app. Teachers value applications that facilitate personalized feedback and enable reflective learning, consistent with the literature on formative assessment and learning analytics in technology-enhanced learning environments.

The study's invariance analyses revealed notable age-related differences, particularly regarding the efficacy-satisfaction link, which was non-significant among teachers over 45 years. Studies by Joo et al. (2018) and Leem and Sung (2018) show that age was one of the most influential factors in perception of the use of innovative technologies. Although many studies suggest that teachers' age does not influence perception and use of gamification or technology, prior experience with active methodologies such as DGBL ultimately conditions a positive attitude in teachers (Fisher et al., 2014, Marín et al., 2020; Smith, 2018; Gómez-Carrasco et al., 2020). This finding suggests that older educators may have distinct motivational or experiential profiles that modulate their satisfaction with gamed tools, aligning with lifespan developmental perspectives on technology adoption (Morris & Venkatesh, 2000). Addressing these differences may require targeted interventions, such as age-sensitive training programs or interface adaptations, to foster inclusive technology integration.

Beyond statistical findings, the study contributes to educational practice by highlighting the need for a holistic approach to gamified application design. Developers should not only ensure alignment with curricular goals but also prioritize usability, adaptive feedback, and inclusivity. Moreover, institutional strategies should focus on enhancing teachers' digital competence and providing ongoing support to facilitate meaningful technology integration (Ertmer & Ottenbreit-Leftwich, 2010). In this sense, the adoption of a gamified app in the classroom must go beyond mere usage to become integrated in a systematized way that attends to the methodological principles that enable students to acquire content and competences that develop democratic values and attitudes (Pektas & Kepceoglu, 2019; Smith, 2018). Although many apps on the market link learning to gaming, their design is not necessarily based on suitable criteria for implementation in formal education, as noted by Kingsley and Grabner-Hagen (2015), Sánchez-Martínez and Ricoy (2017), Fombona-Cadavieco et al. (2020), and Vázquez-Ramos (2021). Professors and teachers find challenges in finding gamified resources, especially in digital format that correspond to different levels of the curriculum across various stages of education, or which can be adapted, or which present an inclusive design that facilitates the participation of all student users in the teaching-learning process, and which provide an enriching experience (Jedel & Palmquist, 2021). Educators report positive experiences with gamified apps in their daily practice when they are easy to use for both teachers and students, a finding consistent with prior studies highlighting ease of use as a decisive factor in the adoption of active methodologies or technologies (Sánchez-Mena et al., 2017; Buabeng-Andoh, 2021; Chocarro et al., 2021).

Furthermore, effective teacher training in gamification during pre-university education is essential. Professional development pathways should empower educators to integrate gamified methodologies coherently with curricular objectives, while fostering both sustainability awareness and ethical use of educational resources. Structured training that combines pedagogical principles, digital literacy, curriculum alignment, and ethical reflection ensures that gamified tools are not only engaging but also responsibly designed and sustainably implemented. This approach aligns with findings by Triantafyllou, Georgiadis, and Sapounidis (2025), who emphasize that gamification is most effective when instructional-design principles ensure alignment with learners' needs and expectations (p. 503). Thus, establishing articulated training itineraries promotes both pedagogical efficacy and ethical, sustainable use in educational contexts.

The study has several limitations, including its cross-sectional design and reliance on self-reported data, which may be subject to bias. Future research should employ longitudinal designs and incorporate objective usage data to validate the observed relationships over time. Additionally, expanding the sample to include diverse educational contexts and cultural settings would enhance the generalizability of the findings. In conclusion, the study advances theoretical understanding by disentangling the complex relationships among pedagogical alignment, technical usability, and teacher satisfaction. It reinforces the view that educational technology acceptance is a multidimensional process shaped by both cognitive and affective factors.

## Conclusion

The use of game-based educational apps is closely aligned with the pedagogical principles of mobile, ubiquitous learning and gamification. Increasingly, in-person education requires the integration of resources that support a variety of learning modalities (face-to face, blended, and remote) while incorporating elements that increase students' motivation to learn and facilitate feedback. In addition, the inclusion of digital devices and resources enables the development of diverse types of active methodologies such as the flipped classroom or problem-solving and challenge-based approaches. In this educational context, game-based learning apps promote mobile, ubiquitous learning of new concepts and competences, supporting and reinforcing content delivered in the classroom. They also increase opportunities for students to review material in a more motivational way.

Educational apps need to demonstrate a clear connection to the curriculum and be evaluated to address ethical and safety concerns. Teachers' adoption or non-adoption of these apps is largely determined by whether they provide support or develop concepts and competences within the curricular material. Although the number of apps available on Apple or Android systems is immense, the number of educational apps suitable for use in educational settings is limited, often due to teachers' lack of awareness, digital competence, or confidence in the use of digital resources. This research has analyzed the curricular factors that most influence the adoption or recommendation of a game-based learning app by teachers in primary education. The most crucial factor is that the app must be clearly aligned with curricular elements, such as content, competences, and education in values. Also, efficacy is predicted by the extent to which the challenges within the app correspond to the assessment criteria set out in the curriculum. Perceived ease of use was also identified as a predictor of teachers' attitudes toward using the game-based learning app. Finally, the investigation found no differences in terms of gender, but age differences were observed; teachers over 45 were less likely to perceive gamified educational apps as useful.

These results should inform the design of future apps, emphasizing that game-based learning apps should be developed by multidisciplinary teams that integrate technical, motivational, pedagogical, and disciplinary solutions. Educational authorities should provide a portal or repository for evaluated educational apps, enabling the identification of materials that effectively support curriculum development and incorporate gamification as a learning strategy.

## Declarations

### *Ethics Statement*

The research presented in this paper was carried out with the support of the Spanish Ministry of Science, through grant number RTI2018-099764-B-100.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

### *Conflict of Interest Statement*

The authors declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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